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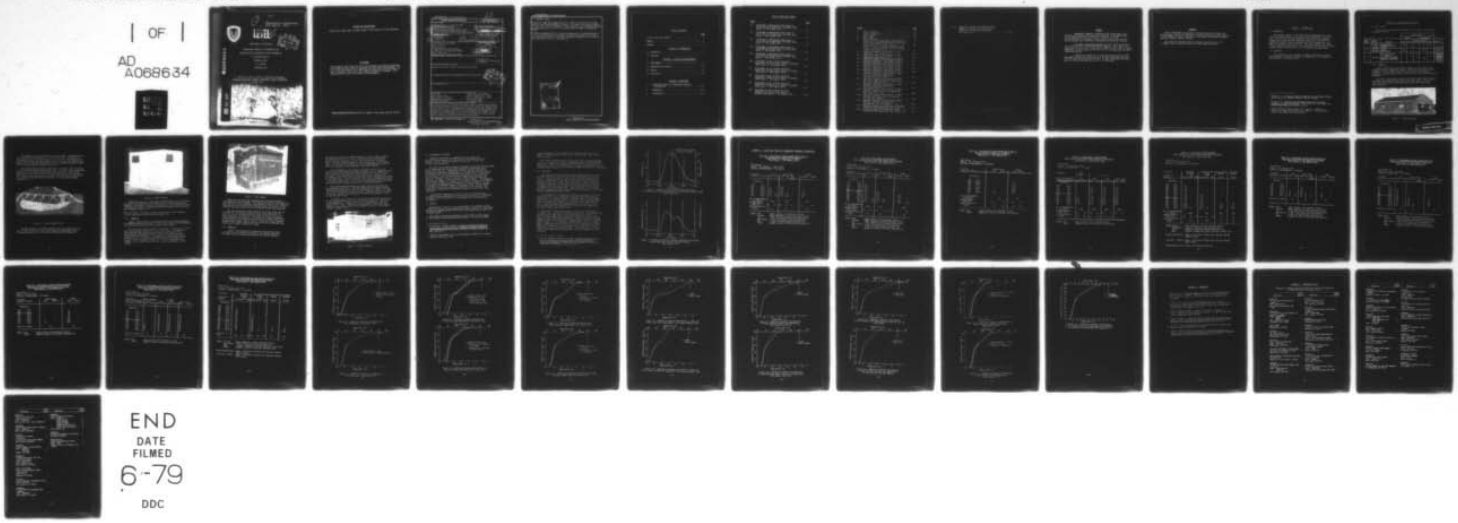

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TECOM Project No. 7 CO OM7 TT3 001

USATTC Report No. 781101

LEVEL

METHODOLOGY INVESTIGATION

TEMPERATURE FREQUENCY DISTRIBUTION DATA ASSOCIATED WITH STRUCTURES ON OPEN EXPOSURE IN THE HUMID TROPICS

TECHNICAL NOTE

W. H. PORTIG

NOVEMBER 1978

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Environmental Criteria	Storage Temperatures, Tropic
Methodology Investigation	Tropic Test Center
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The US Army Tropic Test Center performed a study of Temperature Frequency Distribution Data based on data collected in the Canal Zone from September 1973 to October 1977. Objective was to compile and analyze frequency distributions of surface and induced air temperatures of structures on open exposure in the humid tropics. Data were collected for a number of different structures located in open areas in both the wet and dry seasons and in different orientations for selected structures.

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20. ABSTRACT (cont)

The highest temperature measured was 192°F (89°C) on the metallic ceiling surface of an insulated MILVAN container. The highest roof surface temperature was 180°F (82°C) occurring on a CONEX container, and the highest enclosed air temperature was 142°F (61°C) occurring within an empty, noninsulated MILVAN.

A MILVAN positioned with its long axis running north to south had higher internal air temperatures than an identical MILVAN positioned with its long axis running east to west. The mean temperature difference was 5°F (3°C) at 0900 hours and 4°F (2°C) at 1530 hours.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

SUMMARY

Temperature frequencies obtained on the surfaces and in the interiors of different structures on open exposure in the humid tropics of the Panama Canal Zone are presented. Data were collected for several types of structures located in open areas in both the wet and dry seasons, and in different orientations for selected structures.

The highest temperature measured was 192°F (89°C) on the metallic ceiling surface of an insulated MILVAN container. The highest roof temperature was 180°F (82°C) occurring on a CONEX container, and the highest temperature of the enclosed air was 142°F (61°C) occurring within an empty, noninsulated MILVAN.

A MILVAN positioned with its long axis running north to south had higher internal air temperatures than an identical MILVAN positioned with its long axis running east to west. The mean temperature difference was 5°F (3°C) at 0900 hours and 4°F (2°C) at 1530 hours.

FOREWORD

USATTC acknowledges the assistance and cooperation of the Canal Zone Meteorological Team of the Atmospheric Sciences Laboratory, US Army Electronics R&D Command, and the US Army Materiel Development and Readiness Command Ammunition Center, Savanna, Illinois.

This study was conducted under the technical supervision of Dr. D. A. Dobbins, Chief, Technical Division, US Army Tropic Test Center.

SECTION 1. INTRODUCTION

1.1 BACKGROUND

Two previous reports [1,2] described extreme temperatures in and on structures openly exposed in the humid tropic environment of the Canal Zone. The fact that measured temperatues were higher than expected prompted the US Army Test and Evaluation Command to direct USATTC[3] to compile and analyze frequency distributions of the temperatures from which the extremes had been published. This paper presents the results of this compilation and analysis. It includes several new series of data obtained since the publication of the two reports referenced above.

1.2 OBJECTIVE

The objective of this study was to compile and analyze frequency distributions of surface and induced air temperatures of structures on open exposure in the humid tropics.

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[1] Portig, W. H., Storage and Surface Temperatures in the Humid Tropics, USATTC Report No. 7502002, February 1975 AD: A012801

[2] Portig, W. H., Moisture and Temperature Conditions in Storage Containers in Humid Environments, TECOM Project No. 7CO PB5 TT1 004, USATTC Methodology Investigation in press

[3] Letter DRSTE-ME, TECOM 23 August 1977, subject: Analysis of Climatic Frequency Distribution Data, TRMS No. 7 CO OM7 TT3 001, with 2 Incls, TRMS Forms 1188 and 1189

SECTION 2. DETAILS OF INVESTIGATION

2.1 DATA SOURCES

Three projects produced data suitable for this study. Data sources are summarized below:

Data Source	Seasonal Sample	Structure	Sensor Location: Surfaces: Roof	Surfaces: Ceiling	Surfaces: Stored Goods	Enclosed Air: Center of Structure	Enclosed Air: Other	Remarks
1	Wet, 1973 and Dry, 1974	Butler Building	X			X	X	
		General Purpose Tent	X				X	
		CONEX		X		X		noninsulated
2	Dry and Wet, 1976	CONEX	X			X		noninsulated
		White Camper	X			X		insulated
3	Wet, 1977	MILVAN, insulated (4 vans)		X	X		X	20-25% filled with goods
		MILVAN, noninsulated		X	X		X	20-25% filled with goods
		MILVAN, N-S oriented				X		empty, non-insulated
		MILVAN, E-W oriented				X		empty, non-insulated

2.1.1 Source 1.

Source 1 data consisted of hourly temperature data from Portig's Storage and Surface Temperature report. These were analyzed for three structures: an all-metal storehouse without an attic (a "Butler" building), a general purpose tent, and an all-steel CONEX transportation container.

The Butler Building was located at the Fort Clayton General Purpose Test Area, Chiva Chiva (Pacific side of the Canal Zone). It was 52 feet (16m) long, 36 feet (11m) wide, and 16 feet (5m) high at the ridge (figure 1).

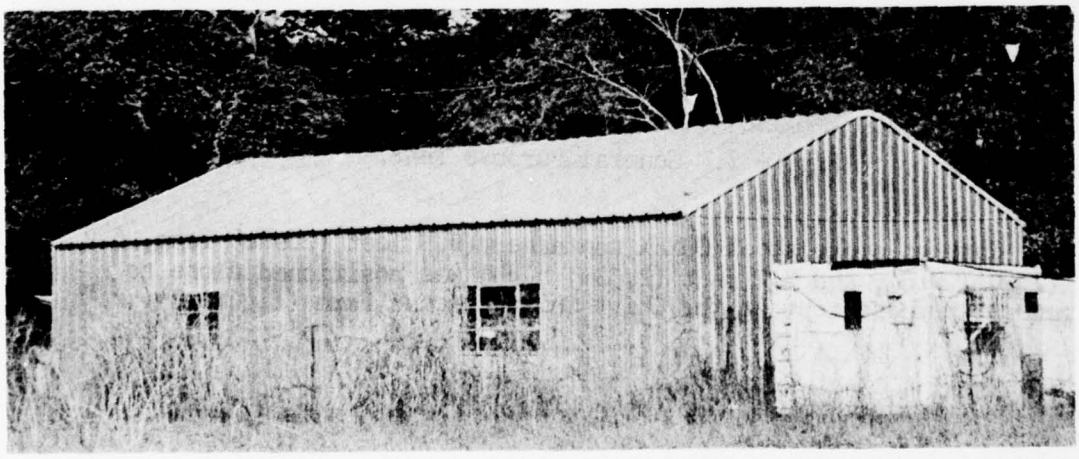

Figure 1. Butler Building

The windows were covered with white venetian blinds. Temperature data were collected using thermocouples at three locations: one glued near the peaked portion of the outer surface of the tin roof, one hanging 3 feet (1m) below the ridge, and one hanging 8 feet (2.4m) above the concrete floor. Hourly data were collected during the periods 28 September through 30 November 1973 and 14 February through 15 April 1974.

The general purpose tent was of medium size (figure 2) and was located on the Chiva Chiva Antenna Farm (Pacific side of the Canal Zone). Temperature data were collected using thermocouples at two locations: one glued to the outside of the fabric close to the highest point of the tent and one inside, hanging 3 feet (1m) above the ground. Hourly data were collected for the periods 12 September through 30 November 1973 and 4 March through 15 April 1974.

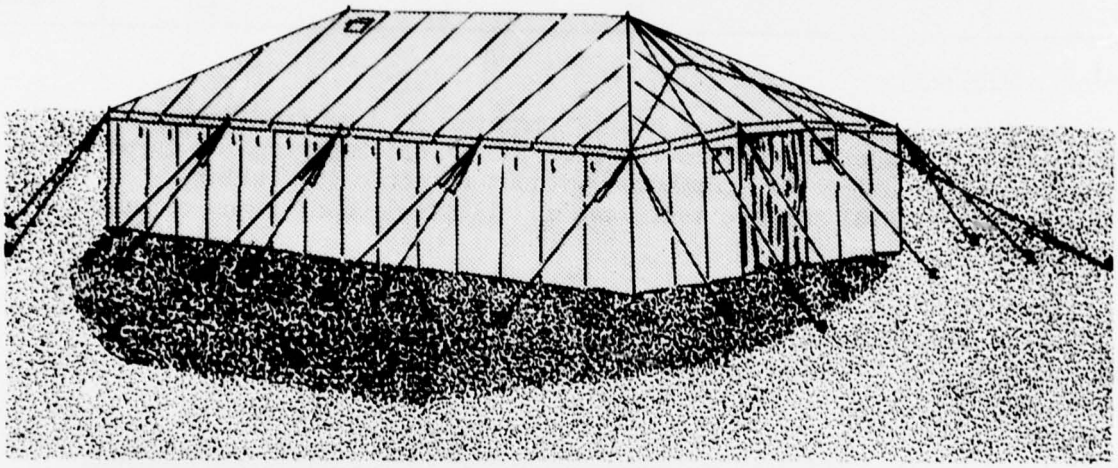

Figure 2. General Purpose Tent.

The dark colored, steel CONEX container (9.5 feet (2.90m) long, 6.9 feet (2.10m) wide, and 7.7 feet (2.35m) high) was positioned close to the general purpose tent at the Chiva Chiva Antenna Farm (figure 3).

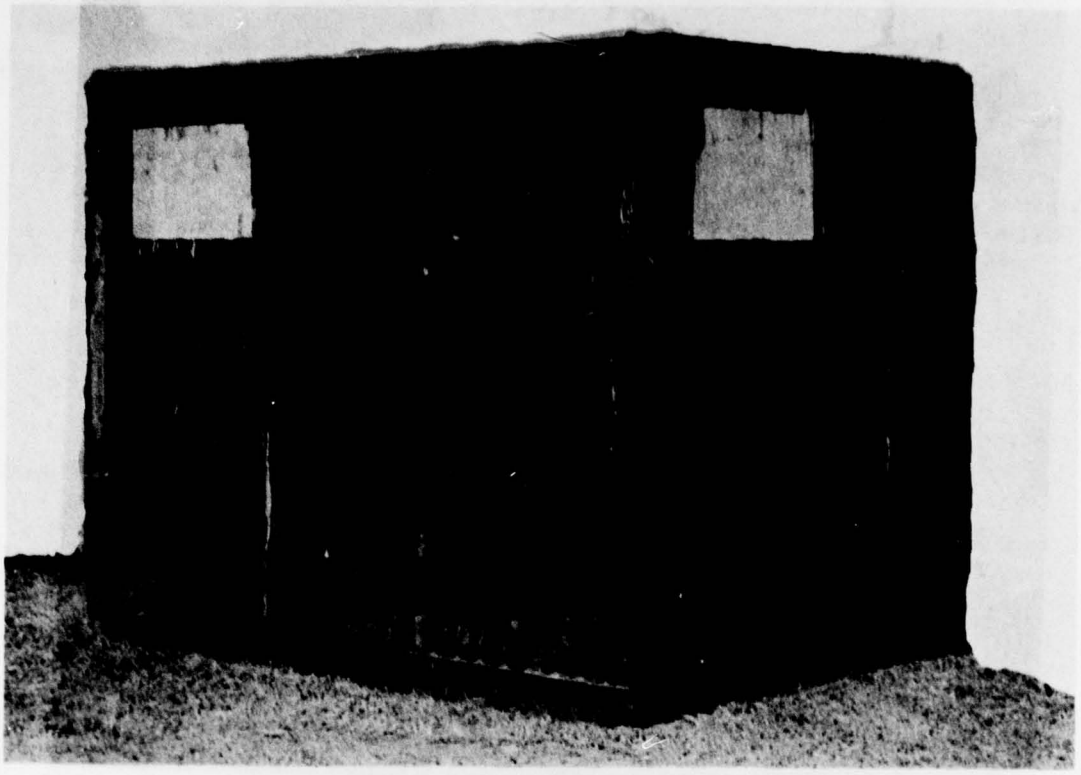

Figure 3. CONEX Container

Temperature data were collected using thermocouples at two locations: one glued to the underside of the upper surface (the ceiling) and one hanging at the geometric center of the container. Hourly data were collected during the periods 12 September through 30 November 1973 and 13 February through 15 April 1974.

NOTE: All Source 1 data were collected and reduced by the Atmospheric Sciences Laboratory, Canal Zone Meterological Team.

2.1.2 Source 2.

Source 2 data consisted of temperature data from Portig's Moisture and Temperature Conditions report. These were analyzed for two containers: an all-steel CONEX transportation container and a camper.

The containers were positioned close together on a grass plot in the Fort Clayton General Purpose Test Area, Chiva Chiva. The CONEX container was the same container previously described under Source 1. The camper was painted white and its walls and ceiling had 1-inch (25mm) fiberglass insulation. Its windows were covered with plywood and there was no ventilation except when the door was opened for inspection of the instruments (figure 4). Its outer dimensions were length 6.3 feet (1.91m), width 4.8 feet (1.45m), and height 5.2 feet (1.57m).

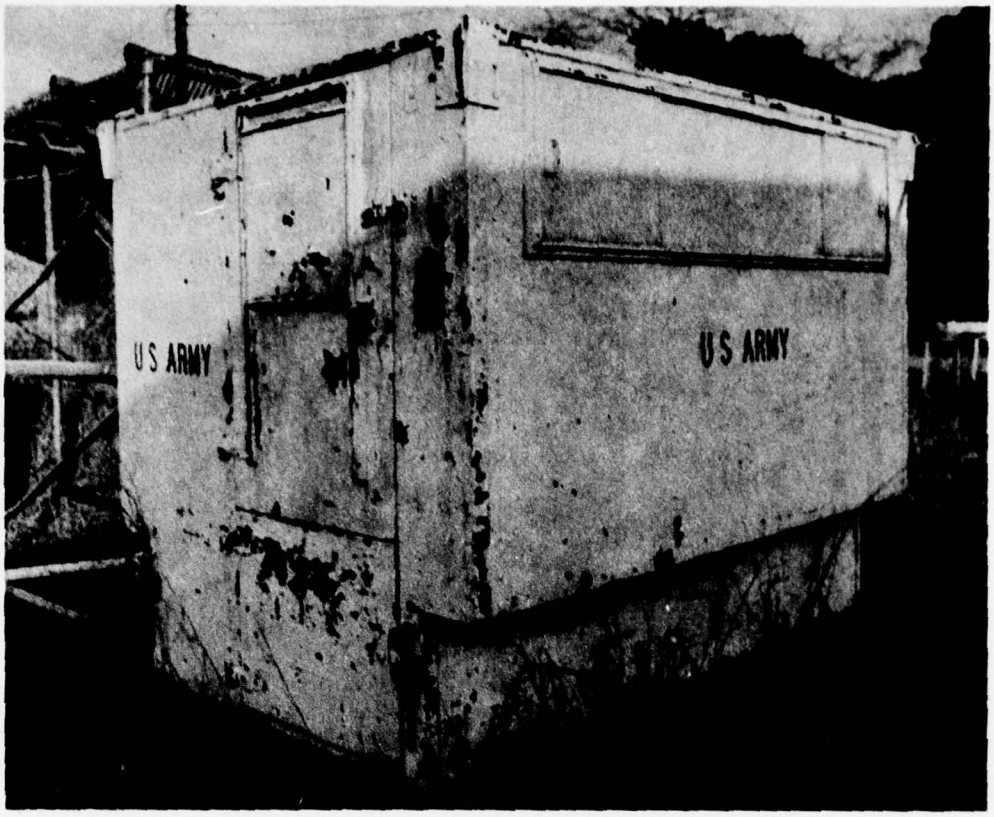

Figure 4. White Camper

Temperature data for both containers were collected by means of thermocouples at two locations: one glued to the center of the upper surface (the roof) and one hanging at the geometric center of the container. Temperatures were recorded every 6 minutes, except for 18 days in July 1976 when data were collected every 90 seconds on the CONEX container.

Data were analyzed at 1-hour intervals for 18 dry season days in February 1976, at 6-minute intervals for 12 rainy season days in June 1976, and at 90-second intervals (CONEX container only) for 18 rainy season days in July 1976. The reason for different treatment of the seasons is that temperature variability is rather small in the dry season but large in the wet season. During the latter, frequent changes between bright sunshine and thick cloud cover (sometimes with rain) caused frequent temperature changes.

2.1.3 Source 3.

Source 3 data consisted of temperature data obtained from a customer test of thermal insulation for five MILVAN containers. The MILVAN test was directed and funded by the US Army Materiel

Development and Readiness Command Ammunition Center, Savanna, Illinois. The test entailed the collection of temperature data on one MILVAN without thermal insulation, and four other MILVANs with different types of ceiling thermal insulation, each approximately 1 inch (25mm) thick. In addition to the MILVAN test data, temperature data were collected and analyzed on two additional noninsulated MILVANs.

The five MILVANs of the thermal insulation test were 20 to 25 percent filled with ammunition packed in wooden crates. Temperature data were collected every 64 minutes using thermistors at three locations: one glued to the underside of the upper surface (the ceiling), one positioned 4 feet (1.2m) above the container floor to measure the container air temperature, and one attached to the surface of ammunition within a centrally located crate. In the four insulated MILVANs, the insulation layer covered the ceiling surface with its attached thermistor.

The two noninsulated MILVANs were empty and were positioned one perpendicular to the other. One MILVAN presented its long side to the rising and setting sun; its long axis running north to south. The long axis of the other MILVAN ran east to west. Temperature data were collected every 64 minutes using thermistors located at the geometric center of the vans (eye level).

All MILVANs were painted olive drab and were positioned in the Fort Clayton General Purpose Test Area, Chiva Chiva (figure 5). Dimensions of the MILVAN were length 20 feet (6.1m), width 8 feet (2.4m) and height 8 feet (2.4m). Temperature data presented in this paper were collected during the periods 28 June through 19 July 1977 and 9 August through 22 October 1977.

Figure 5. MILVAN Container.

2.2 PRESENTATION OF RESULTS

Cumulative frequencies of temperatures were computed and converted into percentages for each series of data discussed in the previous section. They are presented in three ways: in two sets of tables and graphically.

The first set of tables (tables A-1 through A-5) presents the percentage of all temperature measurements which equaled or exceeded specified temperature thresholds. Temperature data base includes both daytime and nighttime temperature measurements. The second set of tables (tables A-6 through A-10), using the same data base as the first set, presents the percentage of days on which specified temperature thresholds were equaled or exceeded. (This second set of tables should be used with care since the number of days with data was rather small.) The graphical presentations (figures A-1 through A-15) follow the example set by Schafer[4] in his report on temperatures of ordnance in different kinds of storage. The graphs have Fahrenheit degrees on the upper scale, Celsius degrees on the lower scale, and accumulated frequencies on the ordinate. The temperature recordings were in Fahrenheit degrees; Celsius values were calculated.

The threshold temperature of 160°F (71.1°C) is the upper limit of "induced storage temperature" as defined in AR 70-38[5]. This threshold is emphasized by a vertical line in the graphs and by underlining in the tables.

2.3 RESULTS

- Temperatures of the air or of stored goods in the containers never reached the "maximum induced storage temperature" of AR 70-38. The highest measured air temperature was 142°F (61°C), occurring within an empty, non-insulated MILVAN.

- The highest temperature measured was 192°F (89°C) on the surface of the ceiling of an insulated MILVAN container. This ceiling surface

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[4] For instance: Schafer, Howard, *A Summary of Measured Temperature Exposure Data of Aircraft Rocket Catapults and Cockpit Equipment*, Naval Weapons Center, China Lake, California, Technical Report No. 5969, July 1977.

[5] "Research, Development, Test, and Evaluation of Materiel for Extreme Climatic Conditions," 1969.

was covered with a 1-inch (25mm) layer of thermal insulation. The highest roof temperature was 180°F (82°C) occurring on a dark-colored CONEX container.

•The MILVAN that presented its long side to the rising and setting sun, i.e., the van with its long axis running north to south, had higher internal air temperatures than an identical MILVAN with its long axis running east to west. The difference was greatest at midforenoon and mid-afternoon (mean differences were 5°F(3°C) at 0900 and 4°F(2°C) at 1530 hours).

2.4 DISCUSSION

Data show that the temperatures at places where goods were or may have been stored were always well below the threshold value of 160°F (71.1°C). There was, however, one location where the temperature frequently rose above this value; namely, the ceiling surface of the insulated MILVANs. This surface was covered with a 1-inch (25mm) layer of thermal insulation. For purposes of storage in the vans, this case is without interest; however, there may be items which have similar configurations in their upper parts. Some helicopters, for instance, have cables between the upper outer shell and an insulation layer beneath. Similar configurations exist in mines.

Even though the air temperatures within the containers were always well below 160°F (71.1°C), they were frequently above human survival temperatures. The general purpose tent, though made to shelter human beings, was often critically hot for survival. These high temperatures were attained while the ambient air was between 86 and 96°F (30 and 36°C). Elsewhere ambient air temperatures up to 136°F (58°C)[6] have been measured, and the probability for excessive inside temperatures may well be higher than reported here.

Data Source 3 contains two series of internal air temperatures of MILVANs, one of which was positioned with its long axis running north to south and the other with its long axis running east to west. As table A-5 shows, temperatures above 120°F (48.9C) were almost twice as frequent in the north-south oriented van. Figure 6 shows the averaged diurnal variation of the internal air temperatures in the vans, and the curve in figure 7 is the difference between the two curves of figure 6. Figure 7 shows that, on the average, air in the north-south positioned MILVAN was at 0900 hours 5°F (3°C) warmer and at 1530 hours 4°F (2°C) warmer than the air in the other MILVAN. These temperature differences occur because different orientation means different exposure to solar radiation.

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[6] See, for instance, Valetto, Jr., John, *Worldwide Distributions of Ambient Temperatures and Temperatures of Materiel Exposed to Direct Solar Radiation*, US Army Engineer Topographic Laboratories, Fort Belvoir, VA, Report ETL-SR-73-2, 1973.

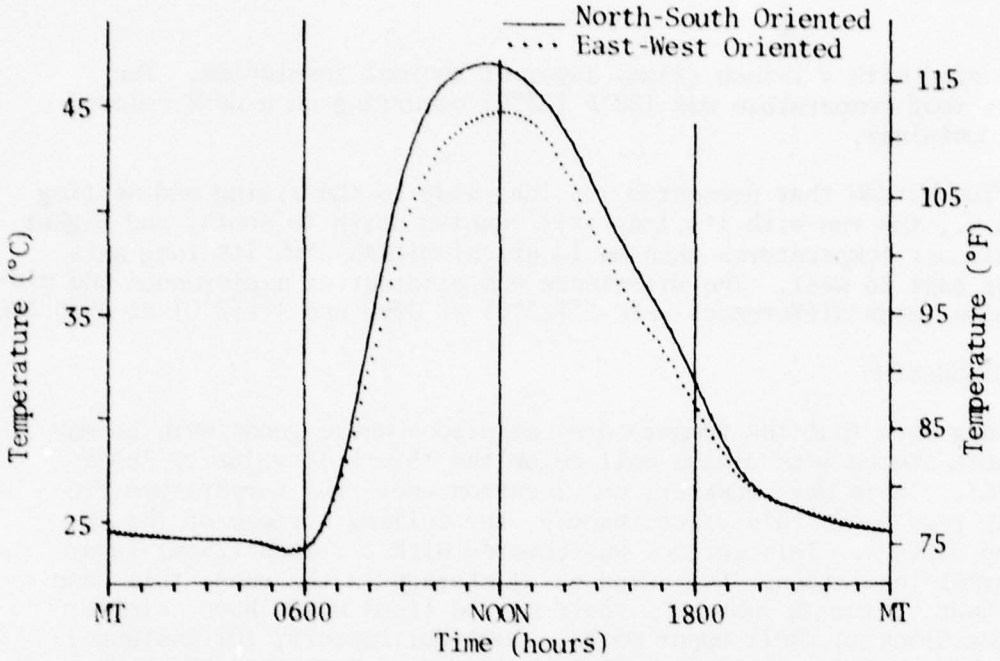

Figure 6. Comparison of Averaged Diurnal Temperatures in a North-South Oriented MILVAN and in an East-West Oriented MILVAN (Wet Season 1977)

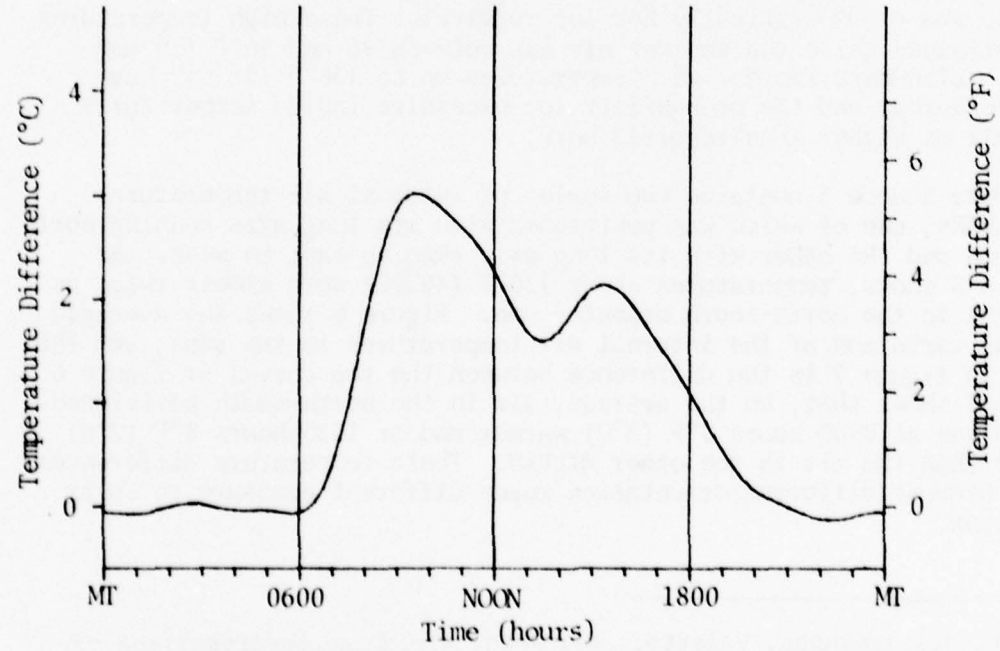

Figure 7. Diurnal Variation of Averaged Temperature Differences of North-South and East-West Oriented MILVANS (Wet Season, 1977)

APPENDIX A. TABLES AND FIGURES OF TEMPERATURE FREQUENCY DISTRIBUTION

Table A-1. Percentages of Measurements Which Equal or Exceed Specified Temperature Thresholds (Data Source 1 - Dry Season, 1974)

Data Source: 1
Season: Dry (February - April 1974)
Interval of Measurements: 60 minutes

Structure:	Tent		Butler Bldg			CONEX	
Location of Sensor:	Roof	Gnd	Roof	Top	Near Center	Ceiling	Center
Threshold							
(°F) (°C)							
155 68.3	-	-	0.3	-	-	-	-
150 65.6	0.5	-	1.0	-	-	-	-
145 62.8	0.9	-	1.6	-	-	-	-
140 60.0	2.0	-	2.6	-	-	0.1	-
130 54.4	4.2	0.1	8.6	4.5	-	2.5	-
120 48.9	7.5	0.5	17.5	16.1	-	12.7	-
No. of measurements per sensor:	1020		1320			1472	
Maximum measurement (°C)	68	56	69	59	47	61	50
Data presented in Figure	A-1		A-3			A-5	

LEGEND
- Roof - upper surface, roof (structure itself)
- Ceiling - upper underface, ceiling (structure itself)
- Top - 3 feet (1m) below roof ridge (enclosed air)
- Near-Center - 8 feet (2.4m) above floor (enclosed air)
- Gnd - 3 feet (1m) above ground (enclosed air)
- Center - geometric center of structure (enclosed air)

Table A-2. Percentages of Measurements
Which Equal or Exceed Specified Temperature Thresholds
(Data Source 1 - Wet Season, 1973)

Data Source: 1
Season: Wet (Sep-Nov 1973)
Interval of Measurements: 60 minutes

Structure:		Tent		Butler Bldg			CONEX	
Location of Sensor:		Roof	Gnd	Roof	Top	Near Center	Ceiling	Center
Threshold								
(°F)	(°C)							
175	79.4	0.1	-	-	-	-	-	-
170	76.7	0.2	-	-	-	-	-	-
165	73.9	0.4	-	-	-	-	-	-
160	71.1	0.8	-	-	-	-	-	-
155	68.3	1.6	-	0.1	-	-	-	-
150	65.6	2.3	-	0.4	-	-	0.1	-
145	62.8	3.3	-	1.0	-	-	0.6	-
140	60.0	4.6	-	1.6	-	-	1.1	-
130	54.4	7.1	0.1	3.9	0.3	-	4.3	-
120	48.9	10.8	1.4	8.1	2.9	-	8.8	0.2
No. of measurements per sensor:		1924		1463			1924	
Maximum measurement (°C)		81	54	71	56	47	67	51
Data presented in Figure		A-2		A-4			A-6	

LEGEND
Roof - upper surface, roof (structure itself)
Ceiling - upper underface, ceiling (structure itself)
Top - 3 feet (1m) below roof ridge (enclosed air)
Near-Center - 8 feet (2.4m) above floor (enclosed air)
Gnd - 3 feet (1m) above ground (enclosed air)
Center - geometric center of structure (enclosed air)

Table A-3. Percentages of Measurements Which Equal or Exceed Specified Temperature Thresholds (Data Source 2 - Dry Season 1976)

Data Source: 2
Season: Dry (February 1977)
Interval of Measurements: 60 minutes

Structure:	White Camper		CONEX	
Location of Sensor:	Roof	Center	Roof	Center
Threshold (°F) (°C)				
160 71.1	-	-	1.5	-
155 68.3	-	-	5.5	-
150 65.6	-	-	9.5	-
145 62.8	-	-	12.8	-
140 60.0	-	-	15.9	-
130 54.4	-	-	20.7	-
120 48.9	4.5	-	27.3	-
No. of measurements per sensor:	421		421	
Maximum measurement (°C)	52	38	72	44
Data presented in Figure	A-7	A-8	A-7	A-8

LEGEND Roof - upper surface, roof (structure itself)
Center - geometric center of structure (enclosed air)

Table A-4. Percentages of Measurements
Which Equal or Exceed Specified Temperature Thresholds
(Data Source 2 - Wet Season, 1976)

Data Source: 2
Season: Wet (June, July 1976)
Interval of Measurements: 6 minutes

Structure:		White Camper		C O N E X							
Date of Measurement:		June		June		July		June & July	
Location of Sensor:		Roof	Center	Roof	Center	Roof	Center	Roof	Center
Threshold									
(°F)	(°C)								
175	79.4	-	-	0.1	-	0.1	-	0.1	-
170	76.7	-	-	0.3	-	0.4	-	0.3	-
165	73.9	-	-	0.9	-	1.3	-	1.1	-
160	71.1	-	-	1.7	-	2.9	-	2.4	-
155	68.3	-	-	2.7	-	5.2	-	4.2	-
150	65.6	-	-	4.4	-	7.9	-	6.5	-
145	62.8	0.1	-	5.8	-	10.6	-	8.6	-
140	60.0	0.5	-	7.9	-	14.1	-	11.5	-
130	54.4	2.8	-	12.0	-	20.2	-	16.8	-
120	48.9	7.3	-	16.7	-	25.5	-	21.9	-
No. of measurements per sensor:		2880		2880		4080		6960	
Maximum measurement (°C)		63	38	80	46	82	47	82	47
Data presented in Figure		A-9	A-10	A-9	A-10	A-11	A-12	-	-

LEGEND Roof - upper surface, roof (structure itself)
Center - geometric center of structure (enclosed air)

Table A-5. Percentages of Measurements
Which Equal or Exceed Specified Temperature Thresholds
Data Source 3 - Wet Season, 1977

Data Source: 3
Season: Wet (Jun-Oct 1977)
Interval of measurements: 64 minutes

Structure:		Insulated MILVANs			Non-Insulated MILVAN			North-South* MILVAN	East-West* MILVAN
Location of Sensor:		Ceiling	Near Ctr	Ammo	Ceiling	Near Ctr	Ammo	Center	Center
Threshold									
(°F)	(°C)								
190	87.8	**	-	-	-	-	-	-	-
185	85.0	0.2	-	-	-	-	-	-	-
180	82.2	0.5	-	-	-	-	-	-	-
175	79.4	1.3	-	-	-	-	-	-	-
170	76.7	2.1	-	-	-	-	-	-	-
165	73.9	3.1	-	-	0.5	-	-	-	-
160	71.1	4.4	-	-	1.2	-	-	-	-
155	68.3	5.8	-	-	2.3	-	-	-	-
150	65.6	7.0	-	-	3.9	-	-	-	-
145	62.8	8.4	-	-	5.7	-	-	-	-
140	60.0	10.0	-	-	8.0	-	-	0.1	**
130	54.4	14.0	-	-	11.5	-	-	3.3	0.9
120	48.9	17.9	0.1	-	16.9	1.8	-	11.2	6.5
No. of measurements per sensor:			9562			2447		1842	1842
Maximum measurement (°C)		89	49	37	81	56	37	61	60
Data presented in Figure			A-13			A-14		A-15	A-15

LEGEND Ceiling - upper underface, ceiling (structure itself)
Near-Center - 8 feet (2.4m) above floor (enclosed air)
Center - geometric center of structure (enclosed air)
Ammo - surface of ammunition within centrally located crate

*North-south MILVAN - empty, noninsulated MILVAN with long axis running north to south

East-west MILVAN - empty, noninsulated MILVAN with long axis running east to west

**Percentage was less than 0.1, but greater than zero

Table A-6. Percentages of Days on Which Specified Temperature Thresholds Were Equaled or Exceeded (Data Source 1 - Dry Season 1974)

Data Source: 1
Season: Dry (Feb-Apr 1974)
Interval of Measurements: 60 minutes

Structure:	Tent		Butler Bldg			CONEX	
Location of Sensor:	Roof	Gnd	Roof	Top	Near Center	Ceiling	Center
Threshold							
(°F) (°C)							
155 68.3	-	-	6	-	-	-	-
150 65.6	7	-	19	-	-	-	-
145 62.8	7	-	30	-	-	-	-
140 60.0	23	-	46	-	-	3	-
130 54.4	35	2	93	57	-	34	-
120 48.9	53	10	98	94	11	95	-
Total No. of Days:	43		54			61	

LEGEND
Roof - upper surface, roof (structure itself)
Ceiling - upper underface, ceiling (structure itself)
Top - 3 feet (1m) below roof ridge (enclosed air)
Near-Center - 8 feet (2.4m) above floor (enclosed air)
Gnd - 3 feet (1m) above ground (enclosed air)
Center - geometric center of structure (enclosed air)

Table A-7. Percentages of Days on Which Specified Temperature Thresholds Were Equaled or Exceeded (Data Source 1 - Wet Season 1973)

Data Source: 1
Season: Wet (Sep - Nov 1973)
Interval of Measurements: 60 minutes

Structure:	Tent		Butler Bldg			CONEX	
Location of Sensor:	Roof	Gnd	Roof	Top	Near Center	Ceiling	Center
Threshold							
(°F) (°C)							
175 79.4	1	-	-	-	-	-	-
170 76.7	4	-	-	-	-	-	-
165 73.9	11	-	-	-	-	-	-
160 71.1	19	-	-	-	-	-	-
155 68.3	30	-	2	-	-	-	-
150 65.6	41	-	10	-	-	2	-
145 62.8	49	-	18	-	-	14	-
140 60.0	59	-	25	-	-	22	-
130 54.4	75	1	52	7	-	55	-
120 48.9	82	22	83	40	-	79	5
Total No. of Days	80		60			80	

LEGEND
Roof - upper surface, roof (structure itself)
Ceiling - upper underface, ceiling (structure itself)
Top - 3 feet (1m) below roof ridge (enclosed air)
Near-Center - 8 feet (2.4m) above floor (enclosed air)
Gnd - 3 feet (1m) above ground (enclosed air)
Center - geometric center of structure (enclosed air)

Table A-8. Percentages of Days on Which Specified Temperature Thresholds Were Equaled or Exceeded (Data Source 2 - Dry Season 1976)

Data Source: 2
Season: Dry (Feb-1976)
Interval of Measurements: 60 minutes

Structure:	White Camper		CONEX	
Location of Sensor:	Roof	Center	Roof	Center
Threshold				
(°F) (°C)				
160 71.1	-	-	28	-
155 68.3	-	-	78	-
150 65.6	-	-	83	-
145 62.8	-	-	89	-
140 60.0	-	-	100	-
130 54.4	-	-	100	-
120 48.9	72	-	100	-
Total No. of days:	18		18	

LEGEND Roof - upper surface, roof (structure itself)
Center - geometric center of structure (enclosed air)

Table A-9. Percentages of Days on Which Specified Temperature Thresholds Were Equaled or Exceeded (Data Source 2 - Wet Season 1976)

Data Source: 2
Season: Wet (Jun, Jul 1976)
Interval of Measurements: 6 minutes

Structure:	White Camper				CONEX			
Date of Measurement:	June		June		July		June & July	
Location of Sensor:	Roof	Center	Roof	Center	Roof	Center	Roof	Center
Threshold (°F)	(°C)							
175	79.4	-	-	17	-	11	-	13	-
170	76.7	-	-	25	-	33	-	30	-
165	73.9	-	-	42	-	67	-	57	-
160	71.1	-	-	50	-	72	-	63	-
155	68.3	-	-	58	-	78	-	70	-
150	65.6	-	-	83	-	83	-	83	-
145	62.8	25	-	92	-	89	-	90	-
140	60.0	33	-	92	-	89	-	90	-
130	54.4	58	-	92	-	94	-	83	-
120	48.9	92	-	92	-	100	-	97	-
Total No. of Days:		12		12		18		30	

LEGEND Roof - upper surface, roof (structure itself)
Center - geometric center of structure (enclosed air)

Table A-10. Percentages of Days on Which Specified Temperature Thresholds Were Equaled or Exceeded (Data Source 3 - Wet Season 1977)

Data Source: 3
Season: Wet (Jun - Oct 1977)
Interval of Measurements: 64 minutes

Structure:	Insulated MILVANs			Non-Insulated MILVAN			North-South* MILVAN	East-West* MILVAN
Location of Sensor:	Near Ceiling	Ctr	Ammo	Near Ceiling	Ctr	Ammo	Center	Center
Threshold								
(°F) (°C)								
190 87.8	1	-	-	-	-	-	-	-
185 85.0	10	-	-	-	-	-	-	-
180 82.2	24	-	-	-	-	-	-	-
175 79.4	39	-	-	1	-	-	-	-
170 76.7	49	-	-	1	-	-	-	-
165 73.9	52	-	-	10	-	-	-	-
160 71.1	61	-	-	25	-	-	-	-
155 68.3	68	-	-	40	-	-	-	-
150 65.6	75	-	-	53	-	-	-	-
145 62.8	80	-	-	60	-	-	-	-
140 60.0	86	-	-	69	-	-	4	1
130 54.4	91	-	-	83	1	-	42	16
120 48.9	92	1	-	89	27	-	73	59
Total No. of Days:	88	84	84	89	84	84	90	90

LEGEND Ceiling - upper underface, ceiling (structure itself)
Near-Center - 8 feet (2.4m) above floor (enclosed air)
Ammo - surface of ammunition within centrally located crate
Center - geometric center of structure (enclosed air)

*North-south MILVAN - empty, noninsulated MILVAN with long axis running north to south
East-west MILVAN - empty, noninsulated MILVAN with long axis running east to west

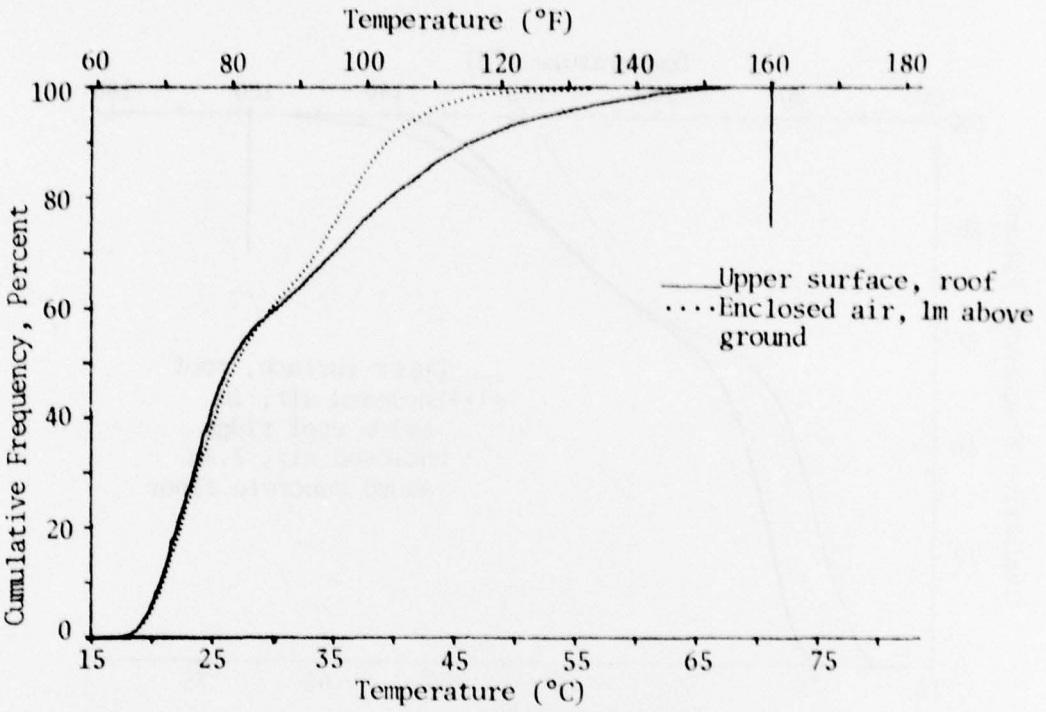

Figure A-1. Cumulative Frequency Distributions of Tent Temperatures (Dry Season, 1974)

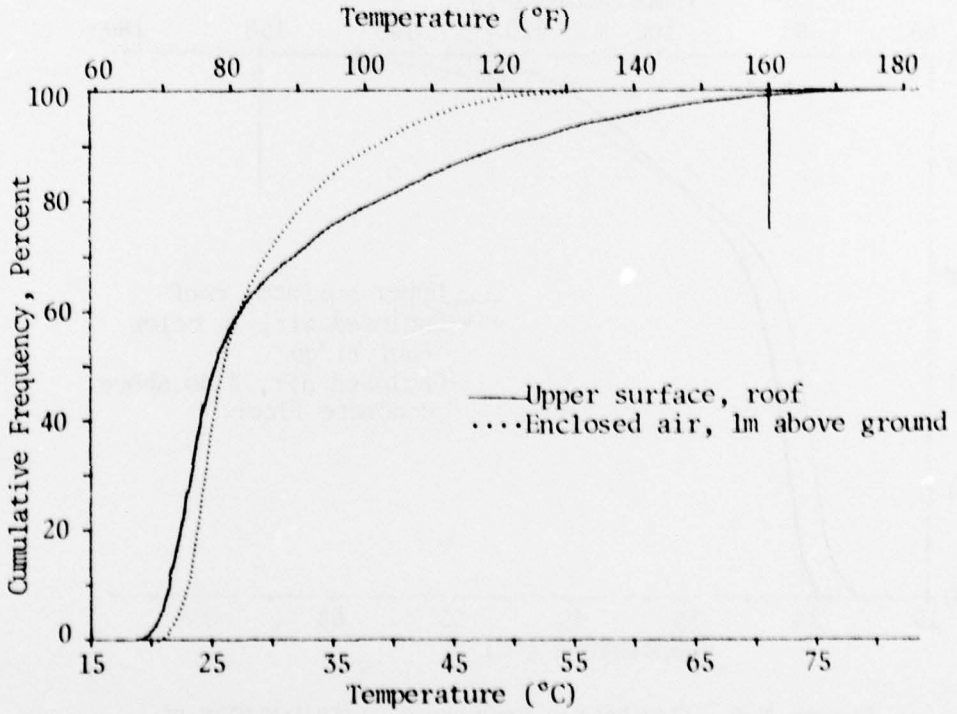

Figure A-2. Cumulative Frequency Distributions of Tent Temperatures (Wet Season, 1973)

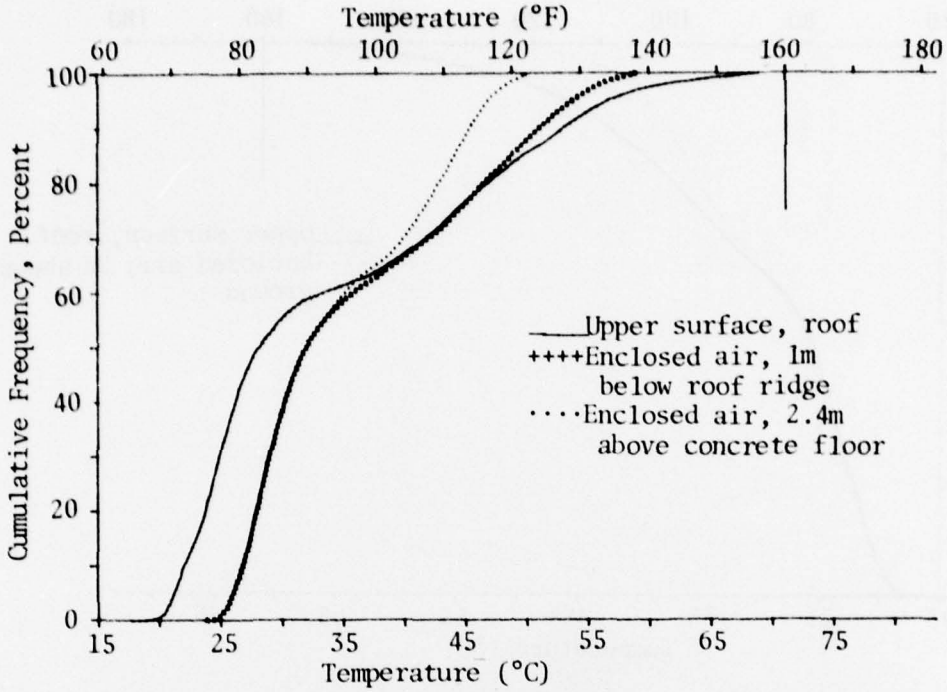

Figure A-3. Cumulative Frequency Distributions of Butler Building Temperatures (Dry Season, 1974)

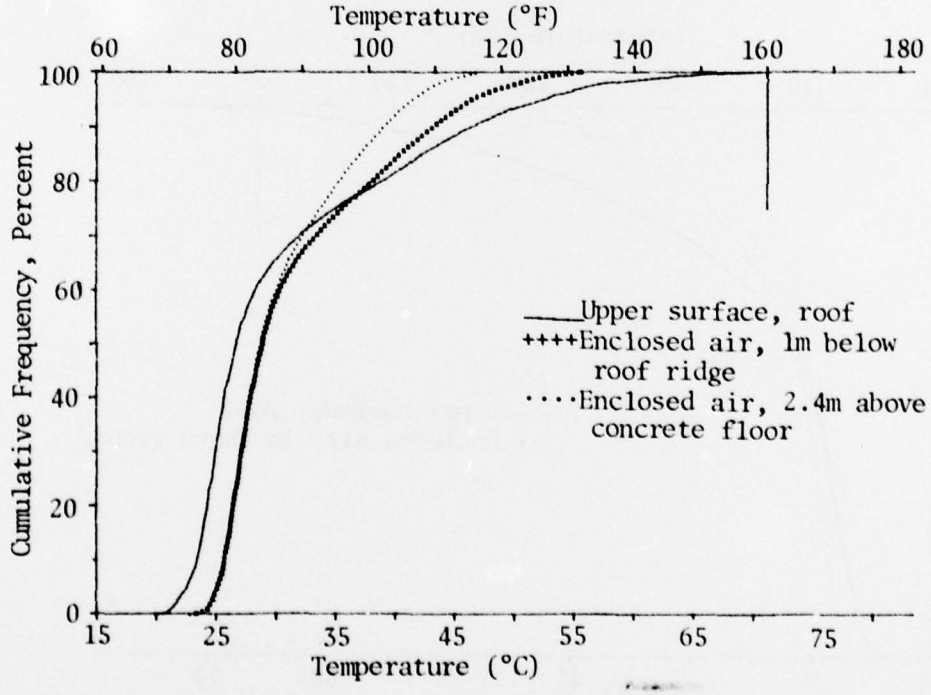

Figure A-4. Cumulative Frequency Distributions of Butler Building Temperatures (Wet Season, 1973)

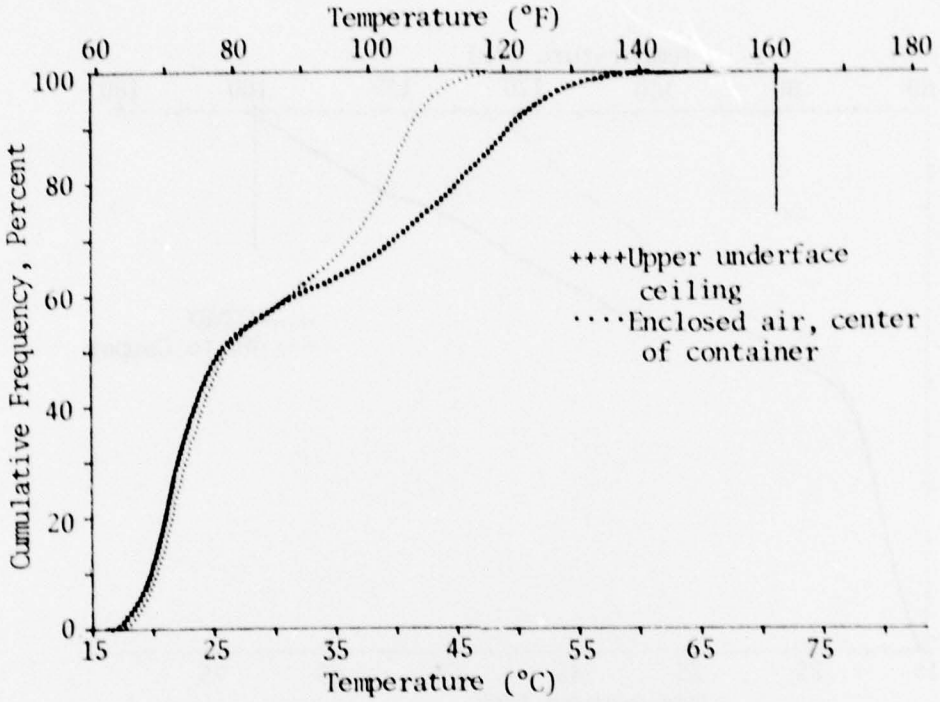

Figure A-5. Cumulative Frequency Distributions of CONEX Container Temperatures (Dry Season, 1974)

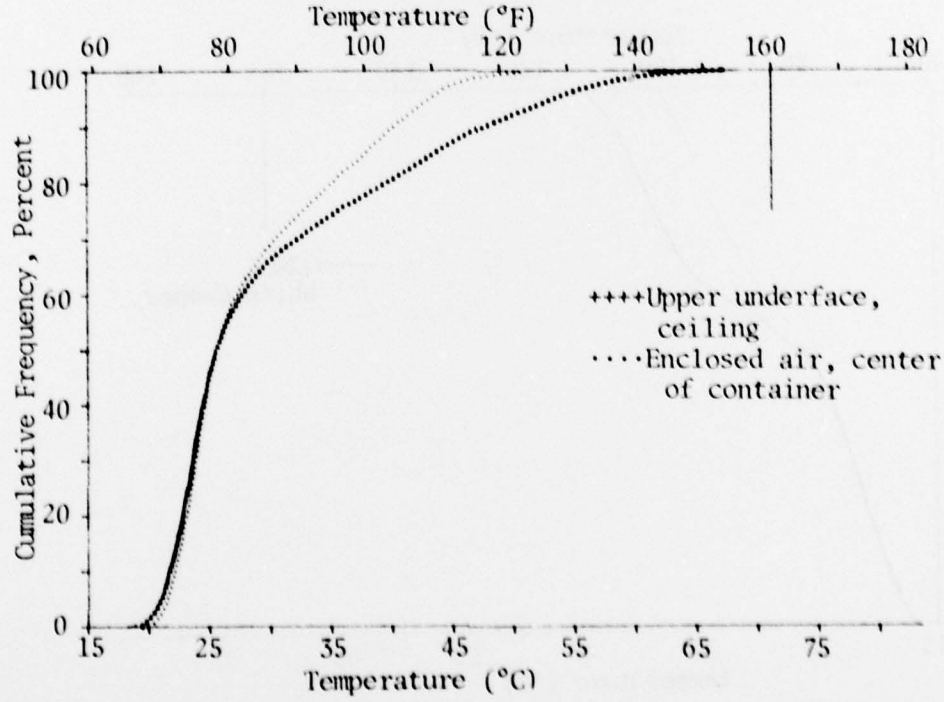

Figure A-6. Cumulative Frequency Distributions of CONEX Container Temperatures (Wet Season, 1973)

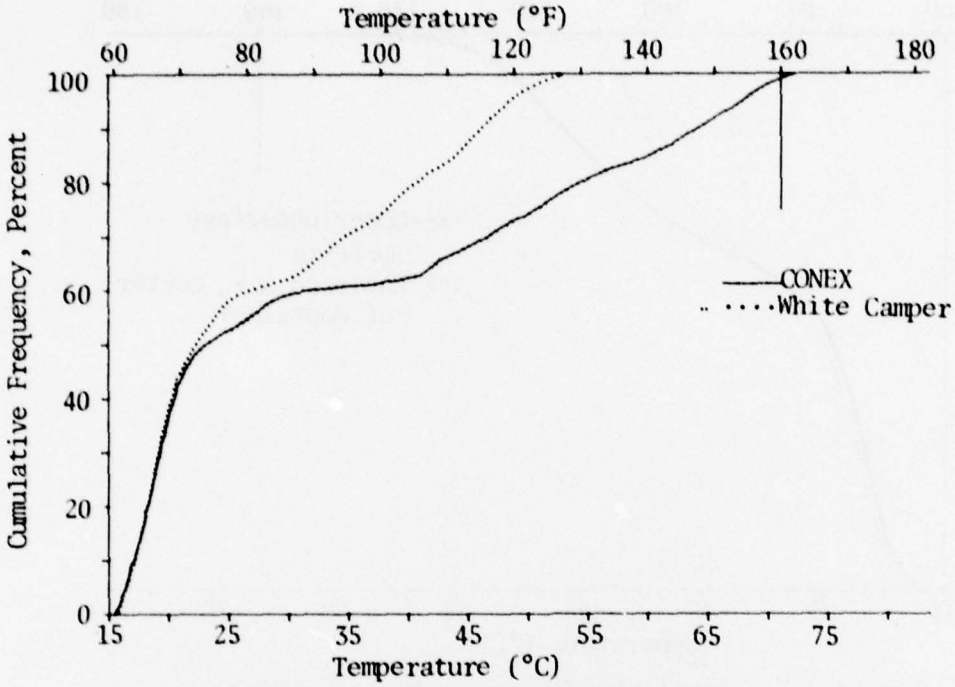

Figure A-7. Cumulative Frequency Distributions of CONEX and White Camper Roof Temperatures (Dry Season, February 1976)

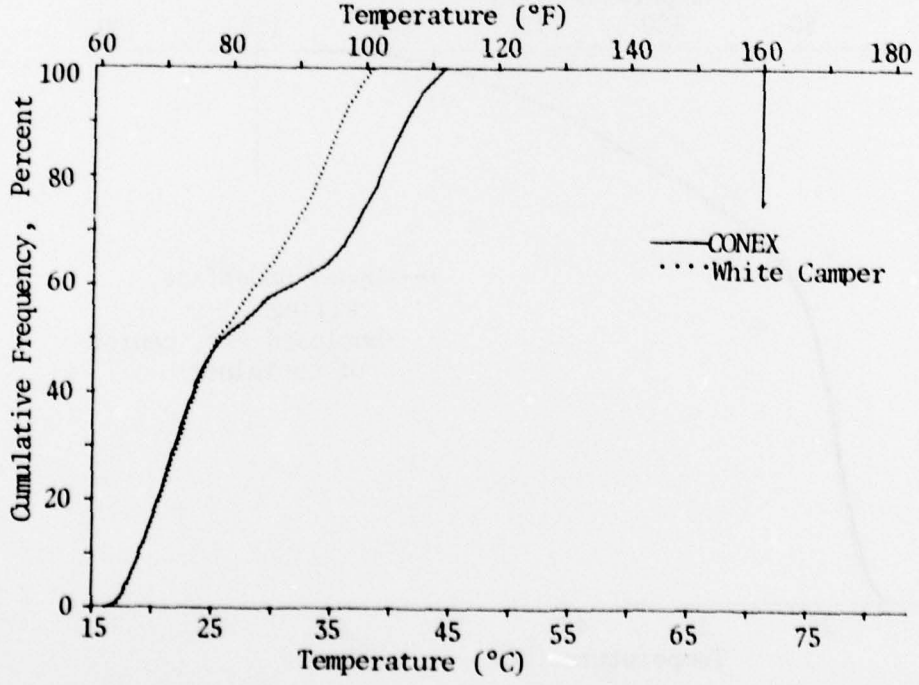

Figure A-8. Cumulative Frequency Distributions of CONEX and White Camper Internal Air Temperatures (Dry Season, February 1976)

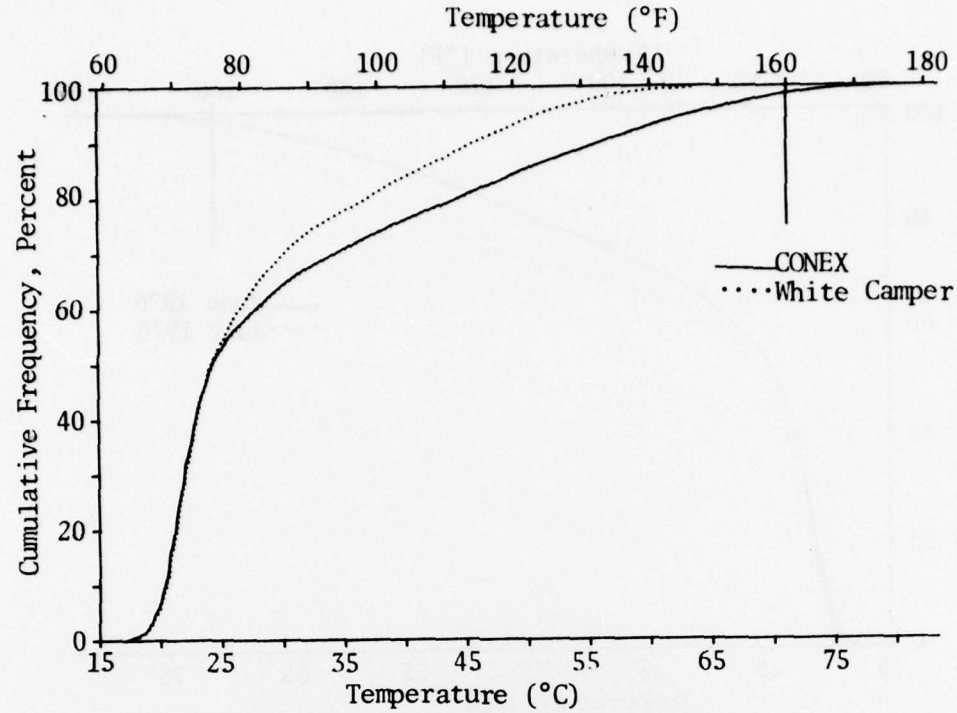

Figure A-9. Cumulative Frequency Distributions of CONEX and White Camper Roof Temperatures (Wet Season, June 1976)

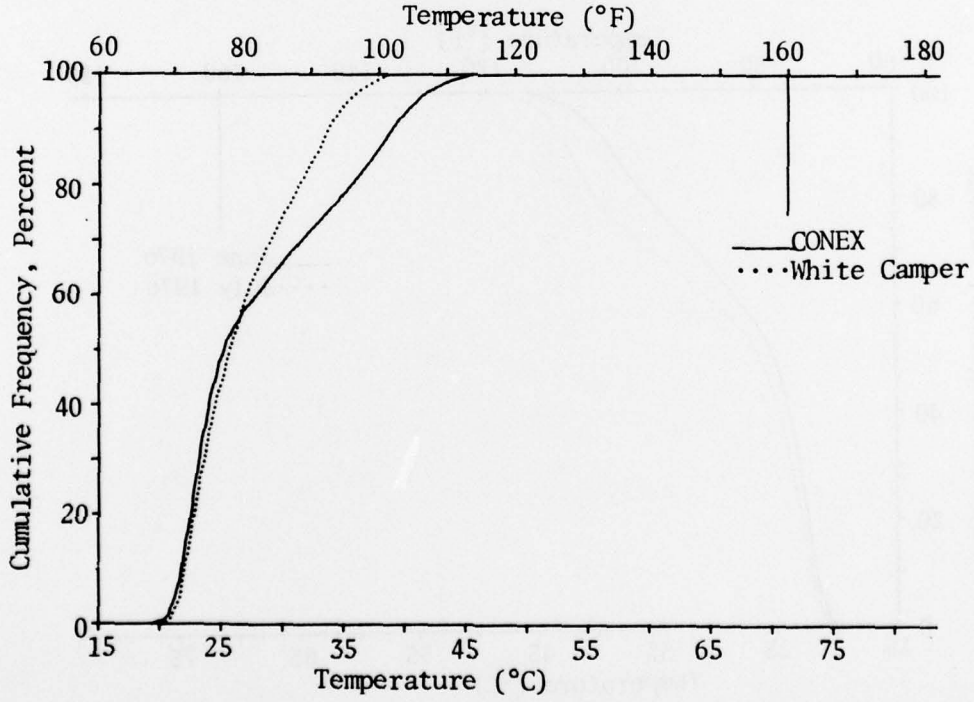

Figure A-10. Cumulative Frequency Distributions of CONEX and White Camper Internal Air Temperatures (Wet Season, June 1976)

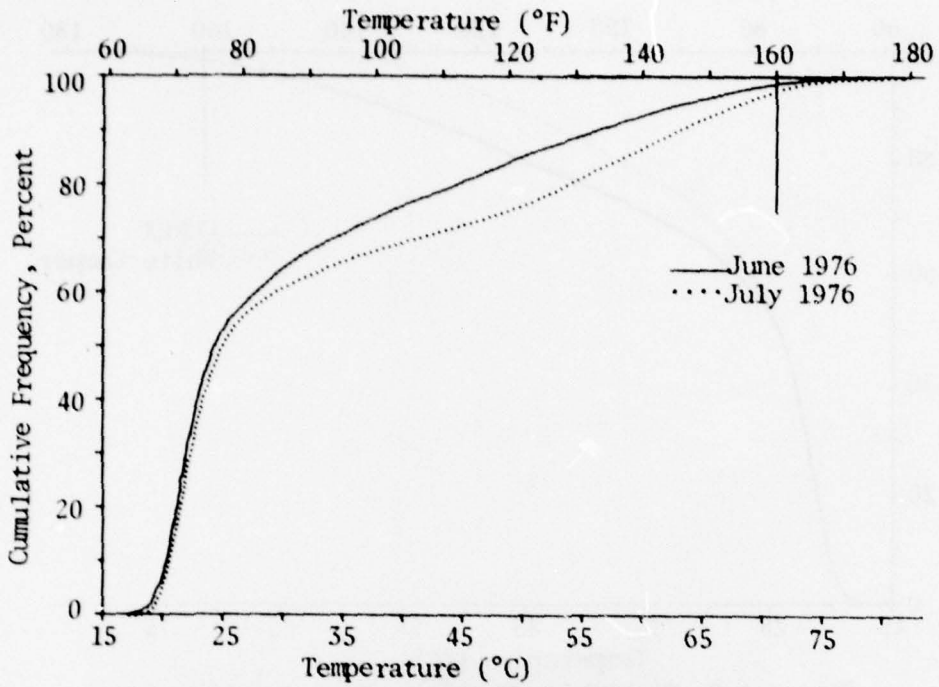

Figure A-11. Cumulative Frequency Distributions of CONEX Container Roof Temperatures for June and July 1976 (Wet Season)

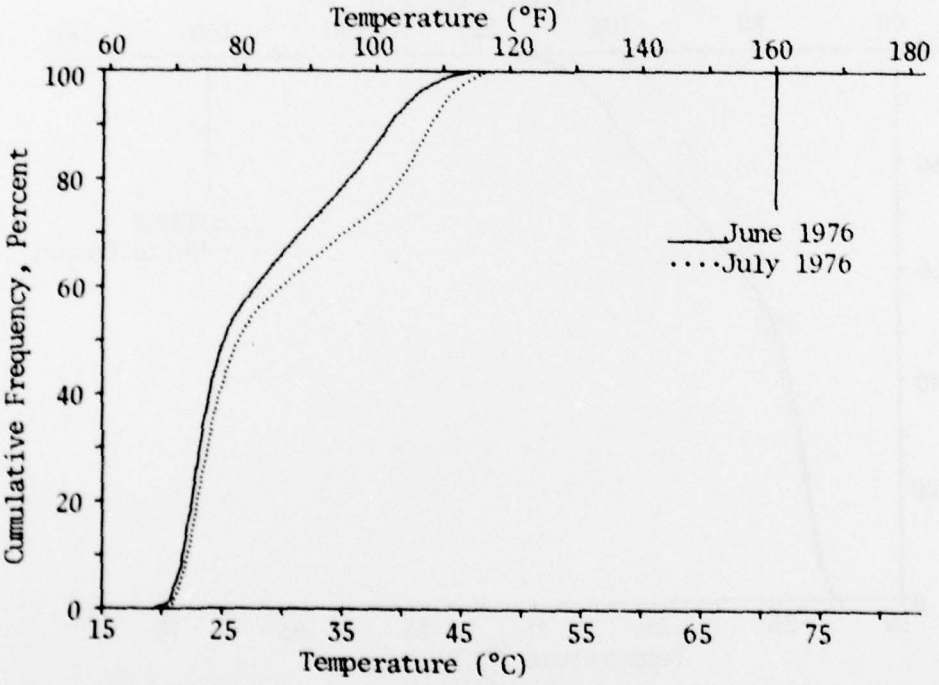

Figure A-12. Cumulative Frequency Distributions of CONEX Container Internal Air Temperatures for June and July 1976 (Wet Season)

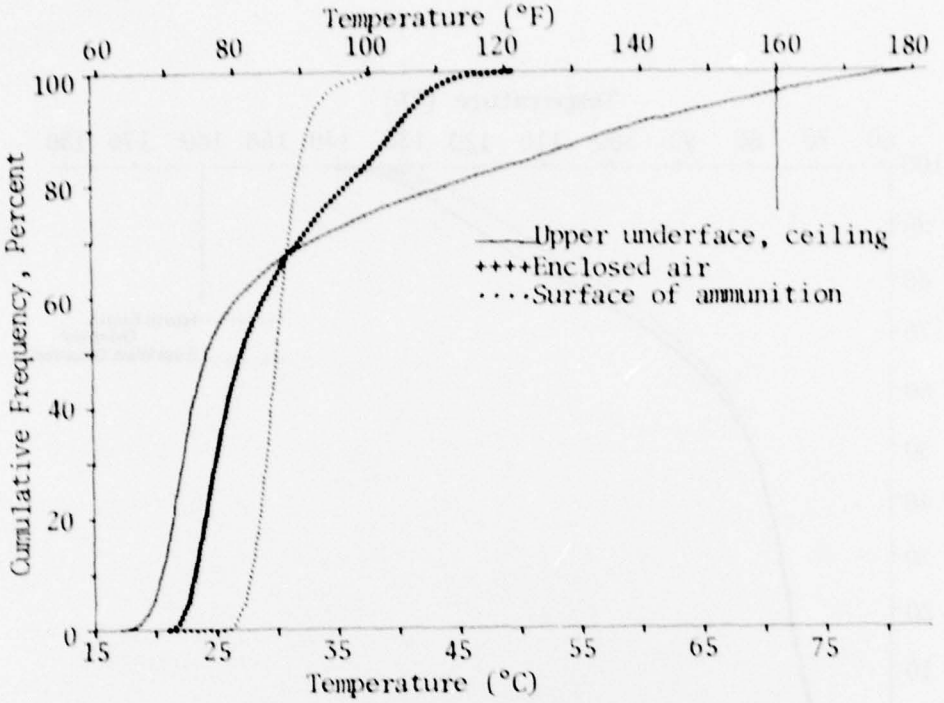

Figure A-13. Cumulative Frequency Distributions of Thermal Insulated MILVAN Temperatures (Wet Season, 1977)

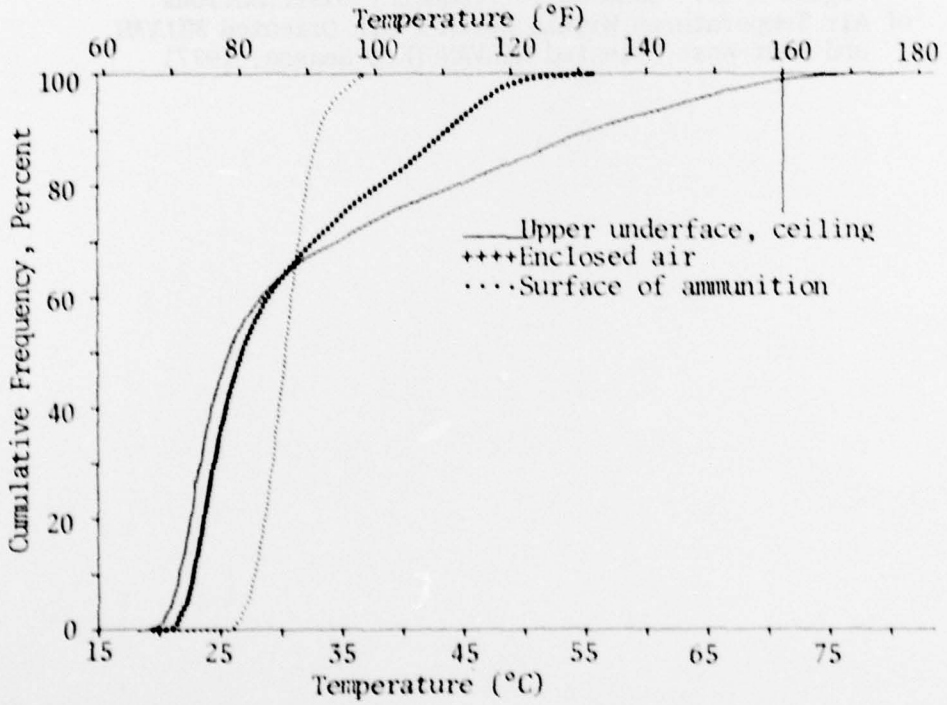

Figure A-14. Cumulative Frequency Distributions of Non-Insulated MILVAN Temperatures (Wet Season, 1977)

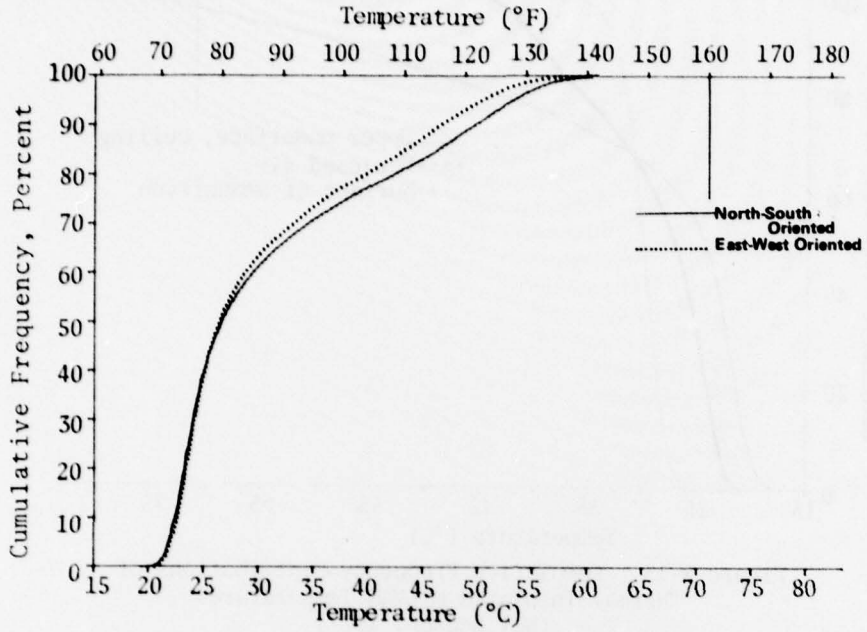

Figure A-15. Cumulative Frequency Distributions of Air Temperatures Within North-South Oriented MILVAN and East-West Oriented MILVAN (Wet Season, 1977)

APPENDIX B. REFERENCES

1. Portig, W. H., *Storage and Surface Temperatures in the Humid Tropics*, USATTC Report No. 7502002, TECOM Project No. 9 CO 009 000 016, US Army Tropic Test Center, Fort Clayton, Canal Zone, February 1975, AD A012801.

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4. Schafer, Howard, *A Summary of Measured Temperature Exposure Data of Aircraft Rocket Catapults and Cockpit Equipment*, Naval Weapons Center, China Lake, CA, NWC Technical Publication No. 5969, July 1977.

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